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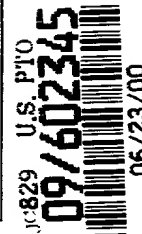
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UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 CFR 1.53(b))

Attorney Docket No. 053313.P017Total Pages 3First Named Inventor or Application Identifier William S. OakleyExpress Mail Label No. EL639015603US

jc829 U.S. PTO

09/602345

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ADDRESS TO: Assistant Commissioner for Patents
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APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

1. XX Fee Transmittal Form
(Submit an original, and a duplicate for fee processing)
2. XX Specification (Total Pages 14)
(preferred arrangement set forth below)
 - Descriptive Title of the Invention
 - Cross References to Related Applications
 - Statement Regarding Fed sponsored R & D
 - Reference to Microfiche Appendix
 - Background of the Invention
 - Brief Summary of the Invention
 - Brief Description of the Drawings (if filed)
 - Detailed Description
 - Claims
 - Abstract of the Disclosure
3. X Drawings(s) (35 USC 113) (Total Sheets 4)
4. X Oath or Declaration (Total Pages 4)
 - a. X Newly Executed (Original or Copy)
 - b. Copy from a Prior Application (37 CFR 1.63(d))
(for Continuation/Divisional with Box 17 completed) (**Note Box 5 below**)
 - i. DELETIONS OF INVENTOR(S) Signed statement attached deleting inventor(s) named in the prior application, see 37 CFR 1.63(d)(2) and 1.33(b).
5. Incorporation By Reference (useable if Box 4b is checked)
The entire disclosure of the prior application, from which a copy of the oath or declaration is supplied under Box 4b, is considered as being part of the disclosure of the accompanying application and is hereby incorporated by reference therein.
6. Microfiche Computer Program (Appendix)

a. _____ Computer Readable Copy
b. _____ Paper Copy (identical to computer copy)
c. _____ Statement verifying identity of above copies

8.	<u> X </u>	Assignment Papers (cover sheet & documents(s))
9.	<u> </u>	a. 37 CFR 3.73(b) Statement (where there is an assignee)
	<u> </u>	b. Power of Attorney
10.	<u> </u>	English Translation Document (if applicable)
11.	<u> </u>	a. Information Disclosure Statement (IDS)/PTO-1449
	<u> </u>	b. Copies of IDS Citations
12.	<u> </u>	Preliminary Amendment
13.	<u> X </u>	Return Receipt Postcard (MPEP 503) (Should be specifically itemized)
14.	<u> </u>	a. Small Entity Statement(s)
		b. Statement filed in prior application, Status still proper and desired
15.	<u> </u>	Certified Copy of Priority Document(s) (if foreign priority is claimed)
16.	<u> X </u>	Other: <u>Express Mail Certification</u>

____ Continuation ____ Divisional ____ Continuation-in-part (CIP)
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Respectfully submitted,

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Serial/Patent No.: ****

Filing/Issue Date: Herewith

Client: Lots Technology, Inc.

Title: MULTI-CHANNEL OPTICAL RECORDING USING VCSEL ARRAYS

BSTZ File No.: 053313.P017

Atty/Secty Initials: ACC/cab

Date Mailed: June 23, 2000

Docket Due Date: ****

The following has been received in the U.S. Patent & Trademark Office on the date stamped hereon:

- ☐ Amendment/Response (____ pgs.)
- ☐ Appeal Brief (____ pgs.) (in triplicate)
- ☒ Application - Utility (14 pgs., with cover and abstract)
- ☐ Application - Rule 1.53(b) Continuation (____ pgs.)
- ☐ Application - Rule 1.53(b) Divisional (____ pgs.)
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- ☒ Assignment and Cover Sheet
- ☒ Certificate of Mailing
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- ☐ Disclosure Docs & Orig & Copy of Inventor's Signed Letter (____ pgs.)
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- ☐ Information Disclosure Statement & PTO 1449 (____ pgs.)
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- ☒ Transmittal Letter, in duplicate
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UNITED STATES PATENT APPLICATION

for

MULTI-CHANNEL OPTICAL RECORDING USING VCSEL ARRAYS

Inventors:

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prepared by:

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File No.: 53313.P017

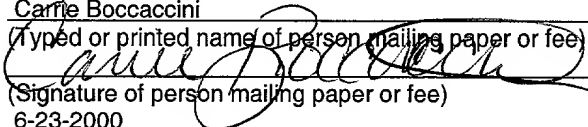
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MULTI-CHANNEL OPTICAL RECORDING USING VCSEL ARRAYS

5 CLAIM OF PRIORITY

This application claims the benefit of United States Provisional Application Serial No. 60/142,548, filed July 7, 1999, entitled "Multi-Channel Optical Recording Using VCSEL Arrays" by William S. Oakley.

10

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to optical recording systems.

Background Information

Optical based systems use light beams to convey and process information. Light beams provide distinct advantages over electrical signals such as higher bandwidth and faster propagation speed. In optical based systems, a light source, such as a laser, is modulated to convey the desired information. By using digital or analog modulation of light beams, optical based systems can be used in a variety of applications, such as optical signal processing and data storage.

Optical recording systems can provide for faster writing of large amounts of data, especially if multiple light sources are used. However, using multiple light sources can increase the complexity and cost of an optical recording system. Thus, it is desirable to have a relatively simple and inexpensive high speed optical recording system.

SUMMARY OF THE INVENTION

The present invention provides an optical recording system having an array of modulatable light sources. An objective lens is positioned relative to the array of modulatable light sources to allow the objective lens to focus at least one light beam from the array of modulatable light sources on a target medium.

In one embodiment of the present invention, the array of modulatable light sources includes an array of Vertical Cavity Surface Emitting Lasers (VCSEL), where each VCSEL of the VCSEL array is capable of writing a separate track on the target medium.

In another embodiment of the present invention, the array of modulatable light sources includes at least one line of modulatable light sources positioned at an angle relative to a direction of movement of said target medium. Each modulatable light source of the line of modulatable light sources is associated with a separate path on the target medium.

Additional features and benefits of the present invention will become apparent upon review of the following description.

BRIEF DESCRIPTION OF THE DRAWINGS

Various embodiments of the present invention will be described in detail with reference to the following drawings. The present invention is illustrated by way of example and not limitation in the accompanying figures.

5

Figure 1 illustrates a top view of an array of light sources tilted at an angle to the direction of movement of a target medium in accordance with the teachings of the present invention.

Figure 2A illustrates a side perspective view of a VCSEL array embedded in a substrate in accordance with the teachings of the present invention.

Figure 2B illustrates a top view of the VCSEL array shown in Figure 2A.

Figure 2C illustrates a top view of a VCSEL array embedded in a substrate at an angle in accordance with the teachings of the present invention.

Figure 3A illustrates generally a diagram of an embodiment of an optical recording system in accordance with the teachings of the present invention.

Figure 3B illustrates generally a diagram of another embodiment of an optical recording system in accordance with the teachings of the present invention.

DETAILED DESCRIPTION

The following description provides embodiments of the present invention.

However, it will be appreciated that other embodiments of the present invention will become apparent to those of ordinary skill in the art upon examination of this description. Thus, the present description and accompanying drawings are for purposes of illustration and are not to be used to construe the invention in a restrictive manner.

Multi-beam optical signal or data recording onto a target medium, such as tape or disc media, may be implemented in accordance with one embodiment of the present invention by use of an array of light sources, such as Vertical Cavity Surface Emitting Lasers (VCSEL), in an orientation as shown in **Figure 1**. A VCSEL is a semiconductor laser diode that emits light vertically from the surface of a substrate, such as a semiconductor wafer. VCSELs are commonly known and can be fabricated using standard microelectronic fabrication techniques. The two dimensional array of regularly spaced light sources 100 is oriented at a slight angle θ to the direction of motion 130 of the target medium as shown in **Figure 1** such that closely spaced tracks can be written on the target medium. It should be noted that light sources 100 are shown in a top-down view. Adjacent light sources 100 are spaced along a row or line by a center-to-center distance 110. Because each line of light sources 100 is positioned at an angle θ to the direction of motion 130 of the target medium, each light source 100 can write a separate, non-overlapping track on the target medium. Recorded data patterns may be achieved on each individual track by modulating each light source 100 independently.

In **Figure 2C**, VCSELs 250 are embedded in substrate 230 at an angle θ .

Specifically, the array of VCSELs 250 features rows or lines of VCSELs 250, and each line is positioned at an angle θ to the direction of motion of the target medium. Each VCSEL 250 emits a light beam vertically from the surface 240 of substrate 230.

- 5 Because VCSELs 250 are already oriented at an angle θ , it is not necessary to rotate substrate 230 to achieve a desired write pattern. However, it is appreciated that both the VCSEL substrate and the VCSEL array may be positioned at an angle to the direction of motion of the target medium in order achieve a desired write pattern on the target medium.

Figure 3A illustrates generally a diagram of an embodiment of an optical recording system using a VCSEL array 302, which may be positioned at an angle as described above with respect to **Figures 1, 2B and 2C**. The VCSEL outputs pass through a collimating lens 304 and are optically polarized after passing through a polarizing beam-splitter 314. Alternatively, the VCSEL outputs may be polarized by the laser emitter design. The polarized light beams then pass through a circularly polarizing element 312, such as a quarter wave plate, coupled to or adjacent polarizing beam-splitter 314. After exiting element 312, the light beams impinge on a target medium 308 via a focusing objective lens 310. Lens 310 is maintained in a desired focal and tracking position by electromechanical servos (not shown) driven by optical signal feedback via system detectors 306. Element 312 causes the light impinging on target medium 308 to be circularly polarized, and the light reflecting from target medium 308 travels back through element 312 and beam-splitter 314 and is placed in a

polarization state such that it is reflected to detection system 306 rather than traveling back to VCSEL array 302.

A second VCSEL array operating in a continuous mode can provide read-after-write capability. This second array can be on a separate substrate, or on the same substrate as the writing VCSEL array, and may be interspersed with the writing VCSELs.

For example, **Figure 3B** illustrates generally a diagram of an optical recording system using two VCSEL arrays 352 and 358, each of which may be positioned at an angle as described above with respect to **Figures 1, 2B and 2C**. The system may employ one VCSEL array 352 for writing and one VCSEL array 358 for reading. The writing VCSEL array 352 may project light beams having one wavelength, and the reading VCSEL array 358 may project light beams having a slightly different wavelength, but both arrays may have the same array spacing. The writing VCSELs may be modulated individually to form the data patterns and the reading VCSELs may be operated in a continuous mode when reading is required. Both VCSEL arrays 352 and 358 may operate simultaneously in a read-after-write mode.

In the two-array configuration shown in **Figure 3B**, a focusing objective lens 362 is sufficiently achromatic to cover different wavelengths so that both VCSEL arrays 352 and 358 focus in the same plane at a target medium 364 with the same magnification. The light beams of VCSEL arrays 352 and 358 having slightly differing wavelengths but similar polarization states are combined through a dichroic polarizing beam-splitter 372 after passing through collimating lenses 354 and 356, respectively. The light beams of writing VCSEL array 352 pass directly through the dichroic polarizing beam-splitter 372

and those of the reading VCSEL array 358 are reflected from the beam-splitter internal dichroic surface. The combined beams exit the dichroic polarizing beam-splitter 372 with the same polarization state and pass through a second polarizing beam-splitter 370 and circularly polarizing plate 360 to target medium 364 via focusing objective lens 362. Lens 362 is maintained in a desired focal and tracking position by electromechanical servos (not shown) driven by optical signal feedback via system detectors 368. On being reflected from target medium 364 and back through plate 360, the light beams have their polarization rotated 90 degrees so that they are reflected from beam-splitter 370 to detection system 368 rather than traveling back to their sources. A filter 366 is placed in the path of the light beams reflected from beam-splitter 370 to remove unwanted write energy and allow the read beams to pass to detection system 368 where data is read out.

In the foregoing detailed description, the apparatus and method of the present invention have been described with reference to specific exemplary embodiments. However, it will be evident that various modifications and changes may be made without departing from the broader scope and spirit of the present invention. The present specification and figures are accordingly to be regarded as illustrative rather than restrictive.

CLAIMS

What is claimed is:

- 1 1. An optical recording system comprising:
2 an array of modulatable light sources; and
3 an objective lens positioned relative to said array of modulatable light sources
4 such that said objective lens is capable of focusing at least one light beam from said
5 array of modulatable light sources on a target medium.
- 1 2. The optical recording system of claim 1 wherein said array of modulatable light
2 sources comprises an array of Vertical Cavity Surface Emitting Lasers (VCSEL).
- 1 3. The optical recording system of claim 2 wherein said VCSEL array is embedded
2 in a substrate.
- 1 4. The optical recording system of claim 3 wherein each VCSEL of said VCSEL
2 array is capable of writing a separate track on said target medium.
- 1 5. The optical recording system of claim 1 wherein said modulatable light sources
2 are spaced at regular intervals.
- 1 6. The optical recording system of claim 5 wherein said regular intervals comprise
2 center-to-center distances of at least approximately 40 microns.
- 1 7. The optical recording system of claim 1 wherein said array of modulatable light
2 sources comprises at least one line of modulatable light sources positioned at an angle
3 relative to a direction of movement of said target medium.

1 8. The optical recording system of claim 7 wherein each modulatable light source of
2 said at least one line of modulatable light sources is associated with a separate path on
3 said target medium.

1 9. The optical recording system of claim 1 further comprising:
2 a polarizing beam-splitter located between said array of modulatable light
3 sources and said objective lens; and
4 a circularly polarizing element located adjacent said polarizing beam-splitter.

1 10. The optical recording system of claim 9 wherein said circularly polarizing element
2 comprises a quarter wave plate.

1 11. An optical recording system comprising:
2 a first array of VCSEL;
3 a second array of VCSEL; and
4 an objective lens located in an optical path of each of said first and second
5 VCSEL arrays, wherein said objective lens is capable of focusing at least one light
6 beam from each of said first and second VCSEL arrays on a target medium.

1 12. The optical recording system of claim 11 wherein said first VCSEL array
2 comprises a writing array and said second VCSEL array comprises a reading array.

1 13. The optical recording system of claim 12 wherein said first VCSEL array
2 comprises a plurality of individually modulatable light sources and said second VCSEL
3 array comprises a plurality of continuously operable light sources.

1 14. The optical recording system of claim 12 wherein:

2 said first VCSEL array is capable of emitting a plurality of light beams having a
3 first wavelength;
4 said second VCSEL array is capable of emitting a plurality of light beams having
5 a second wavelength different from said first wavelength; and
6 said objective lens is achromatic.

1 15. The optical recording system of claim 12 wherein each VCSEL of said first
2 VCSEL array is capable of writing a separate track on said target medium.

1 16. The optical recording system of claim 15 wherein said first VCSEL array is
2 positioned at an angle relative to a direction of movement of said target medium.

1 17. The optical recording system of claim 11 wherein said first and second VCSEL
2 arrays are located on separate substrates.

1 18. The optical recording system of claim 11 wherein said first and second VCSEL
2 arrays are located on a common substrate.

1 19. The optical recording system of claim 11 wherein said first and second VCSEL
2 arrays have the same array spacing.

1 20. The optical recording system of claim 12 further comprising:
2 a first polarizing beam-splitter located between said first VCSEL array and said
3 objective lens;
4 a second polarizing beam-splitter located between said first polarizing beam-
5 splitter and said objective lens; and
6 a circularly polarizing plate located adjacent said second polarizing beam-splitter.

1 21. The optical recording system of claim 20 wherein said first polarizing beam-
2 splitter comprises a dichroic polarizing beam-splitter.

1 22. An optical recording system comprising:
2 a writing array of VCSEL;
3 a reading array of VCSEL;
4 a dichroic polarizing beam-splitter positioned to receive a plurality of light beams
5 from each of said writing VCSEL array and said reading VCSEL array;
6 a polarizing beam-splitter positioned to receive said light beams upon said light
7 beams exiting said dichroic polarizing beam-splitter;
8 a circularly polarizing plate coupled to an exit face of said polarizing beam-
9 splitter;
10 an achromatic objective lens positioned to receive said light beams upon said
11 light beams exiting said circularly polarizing plate, wherein said objective lens is
12 capable of focusing said light beams on a target medium;
13 at least one adjustment device coupled to said objective lens to adjust a position
14 of said objective lens;
15 a detection system positioned to receive said light beams upon said light beams
16 reflecting from said target medium, said detection system capable of providing data to
17 control said at least one adjustment device.

ABSTRACT OF THE DISCLOSURE

A multi-beam optical recording system having an array of light sources, such as Vertical Cavity Surface Emitting Lasers (VCSEL), oriented to the direction of motion of an optically sensitive recording medium such that each light source forms a separate written track.

Figure 1 is a schematic diagram of a particle beam 100 passing through a channel 110. The channel is defined by two dashed lines. The beam consists of particles 120, represented by small circles. An angle θ is indicated between the beam's path and the lower boundary of the channel. Arrows indicate the direction of flow from left to right.

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Figure 2A

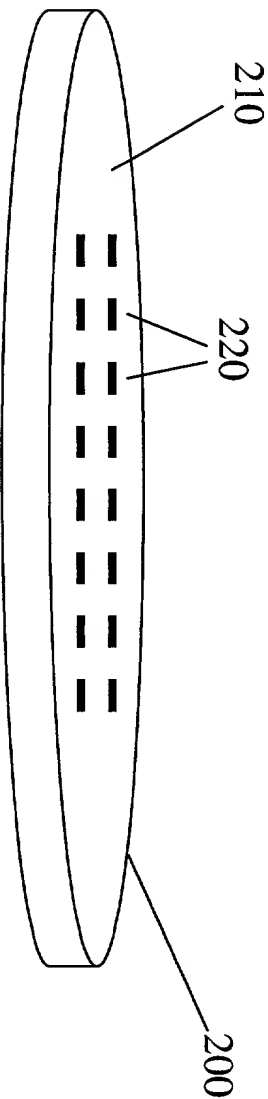


Figure 2B

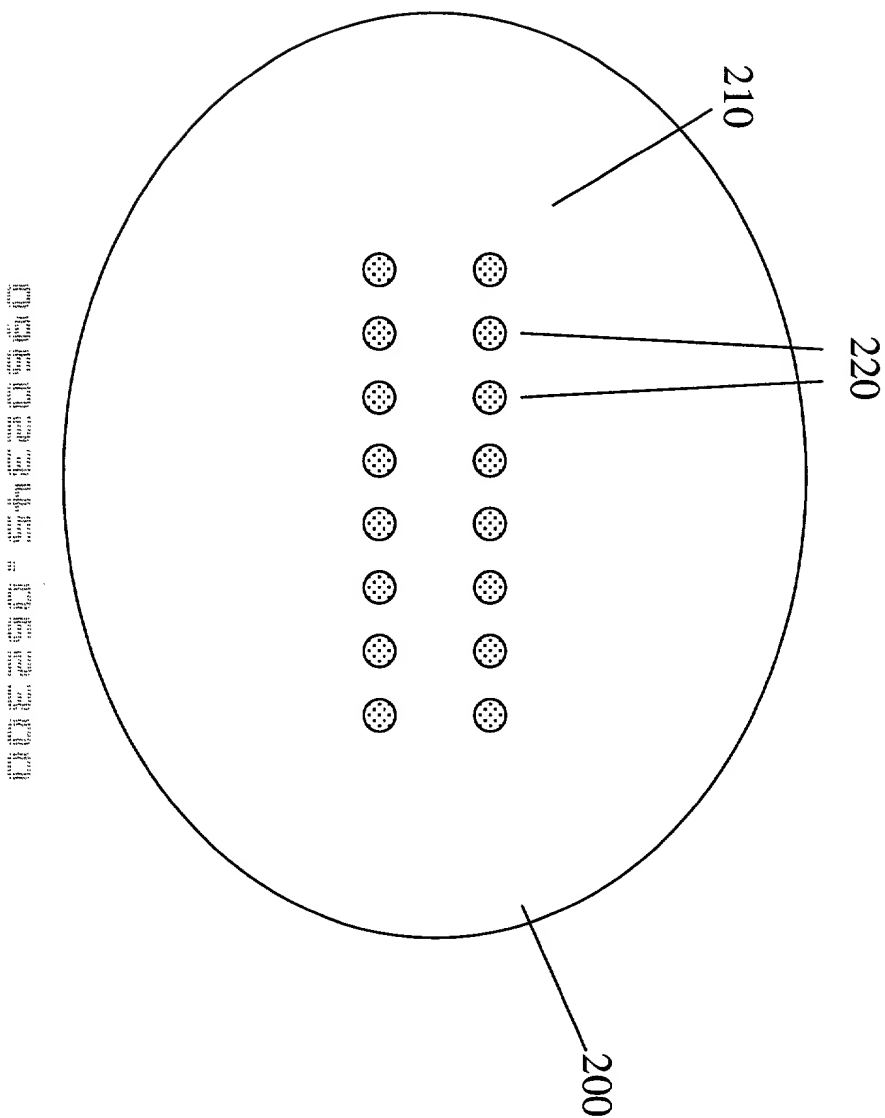
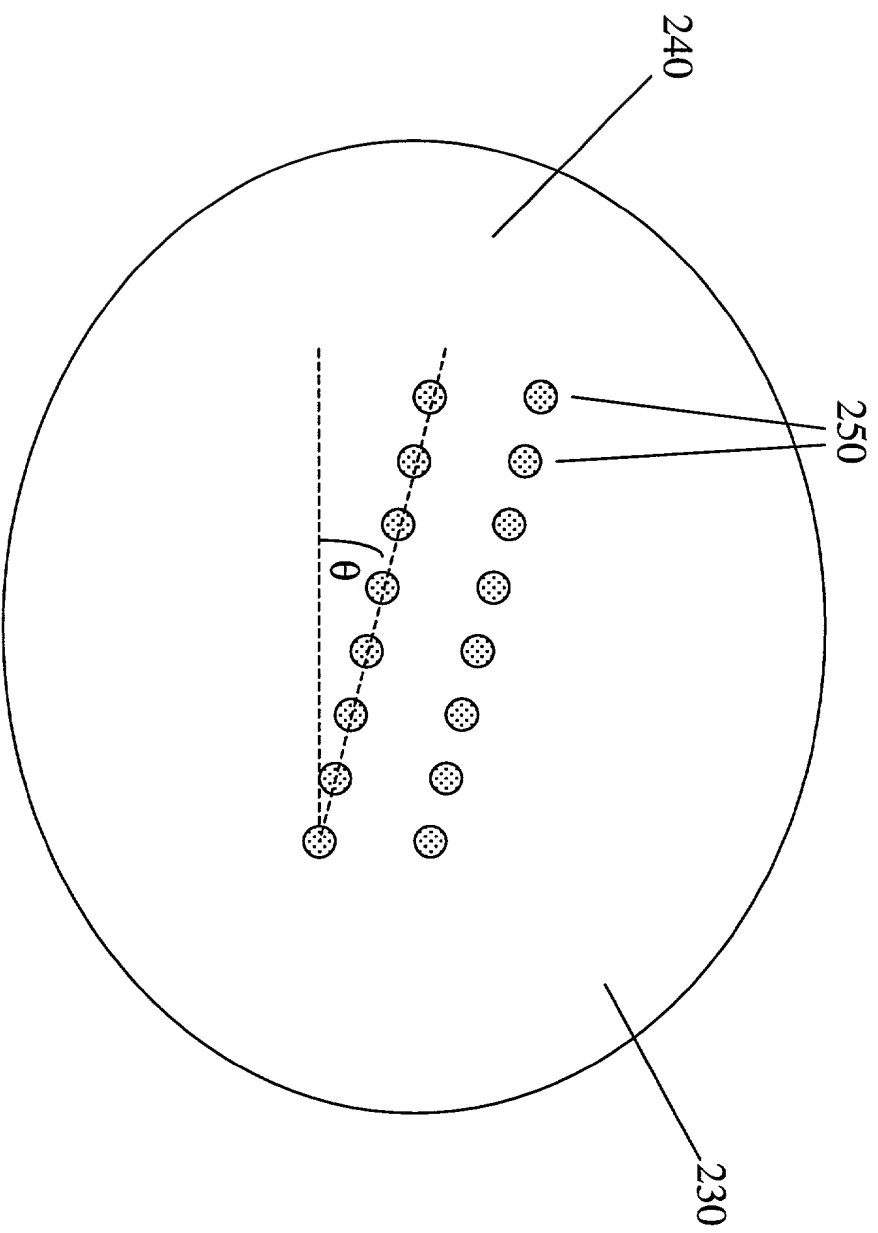


Figure 2C



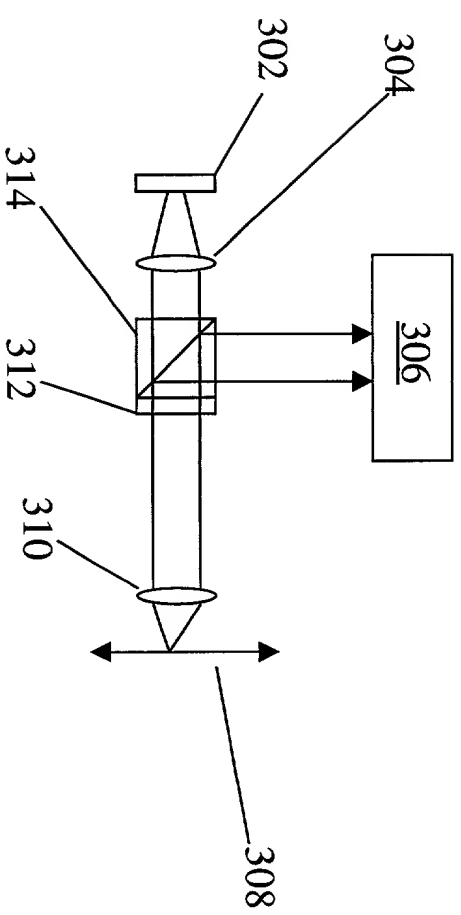


Figure 3A

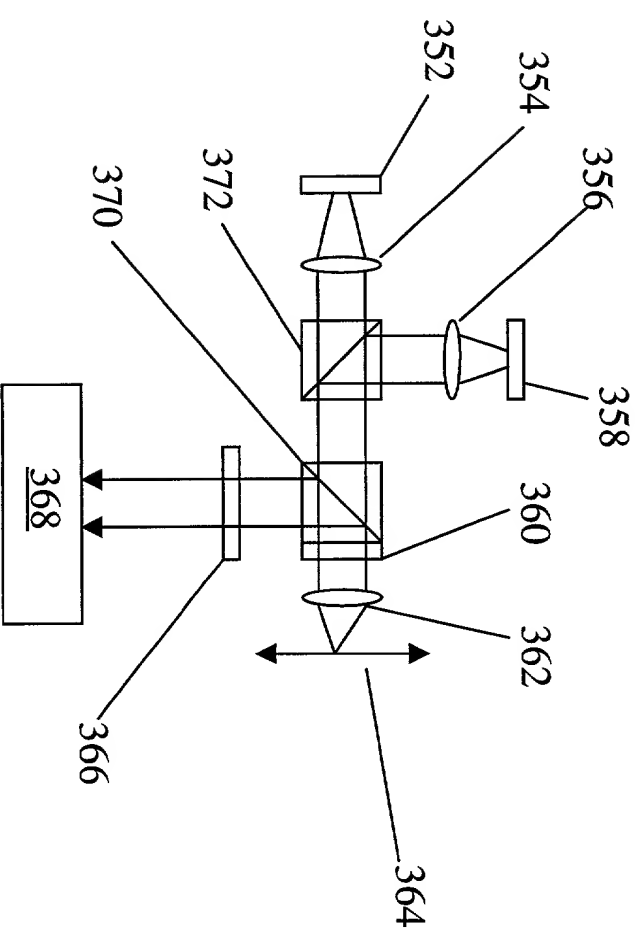


Figure 3B

DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below, next to my name.

I believe I am the original, first, and sole inventor (if only one name is listed below) or an original, first, and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled
MULTI-CHANNEL OPTICAL RECORDING USING VCSEL ARRAYS

the specification of which

X is attached hereto.
 was filed on _____ as
 United States Application Number _____
 or PCT International Application Number _____
 and was amended on _____
 (if applicable)

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claim(s), as amended by any amendment referred to above.

I acknowledge the duty to disclose all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, Section 119(a)-(d), of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

<u>Prior Foreign Application(s)</u>			<u>Priority Claimed</u>	
<u>Number</u>	<u>Country</u>	<u>Day/Month/Year Filed</u>	<u>Yes</u>	<u>No</u>
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____

I hereby claim the benefit under Title 35, United States Code, Section 119(e) of any United States provisional application(s) listed below:

<u>60/142,548</u>	<u>July 7, 1999</u>
Application Number	Filing Date
_____	_____
Application Number	Filing Date

I hereby claim the benefit under Title 35, United States Code, Section 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, Section 112, I acknowledge the duty to disclose all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application:

_____	_____	_____
Application Number	Filing Date	Status -- patented, pending, abandoned

_____	_____	_____
Application Number	Filing Date	Status -- patented, pending, abandoned

I hereby appoint the persons listed on Appendix A hereto (which is incorporated by reference and a part of this document) as my respective patent attorneys and patent agents, with full power of substitution and revocation, to prosecute this application and to transact all business in the Patent and Trademark Office connected herewith.

Send correspondence to Andrew C. Chen, BLAKELY, SOKOLOFF, TAYLOR &
(Name of Attorney or Agent)
ZAFMAN LLP, 12400 Wilshire Boulevard 7th Floor, Los Angeles, California 90025 and direct
telephone calls to Andrew C. Chen, (408) 720-8300.
(Name of Attorney or Agent)

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full Name of Sole/First Inventor William S. Oakley

Inventor's Signature William S. Oakley Date 22 June 2000

Residence Burlingame, California Citizenship U.S.A.
(City, State) (Country)

Post Office Address 1566 Cypress Ave.
Burlingame, CA 94010

APPENDIX B

Title 37, Code of Federal Regulations, Section 1.56 Duty to Disclose Information Material to Patentability

(a) A patent by its very nature is affected with a public interest. The public interest is best served, and the most effective patent examination occurs when, at the time an application is being examined, the Office is aware of and evaluates the teachings of all information material to patentability. Each individual associated with the filing and prosecution of a patent application has a duty of candor and good faith in dealing with the Office, which includes a duty to disclose to the Office all information known to that individual to be material to patentability as defined in this section. The duty to disclosure information exists with respect to each pending claim until the claim is cancelled or withdrawn from consideration, or the application becomes abandoned. Information material to the patentability of a claim that is cancelled or withdrawn from consideration need not be submitted if the information is not material to the patentability of any claim remaining under consideration in the application. There is no duty to submit information which is not material to the patentability of any existing claim. The duty to disclose all information known to be material to patentability is deemed to be satisfied if all information known to be material to patentability of any claim issued in a patent was cited by the Office or submitted to the Office in the manner prescribed by §§1.97(b)-(d) and 1.98. However, no patent will be granted on an application in connection with which fraud on the Office was practiced or attempted or the duty of disclosure was violated through bad faith or intentional misconduct. The Office encourages applicants to carefully examine:

(1) Prior art cited in search reports of a foreign patent office in a counterpart application, and

(2) The closest information over which individuals associated with the filing or prosecution of a patent application believe any pending claim patentably defines, to make sure that any material information contained therein is disclosed to the Office.

(b) Under this section, information is material to patentability when it is not cumulative to information already of record or being made of record in the application, and

(1) It establishes, by itself or in combination with other information, a prima facie case of unpatentability of a claim; or

(2) It refutes, or is inconsistent with, a position the applicant takes in:

(i) Opposing an argument of unpatentability relied on by the Office, or

(ii) Asserting an argument of patentability.

A prima facie case of unpatentability is established when the information compels a conclusion that a claim is unpatentable under the preponderance of evidence, burden-of-proof standard, giving each term in the claim its broadest reasonable construction consistent with the specification, and before any consideration is given to evidence which may be submitted in an attempt to establish a contrary conclusion of patentability.

(c) Individuals associated with the filing or prosecution of a patent application within the meaning of this section are:

(1) Each inventor named in the application;

(2) Each attorney or agent who prepares or prosecutes the application; and

(3) Every other person who is substantively involved in the preparation or prosecution of the application and who is associated with the inventor, with the assignee or with anyone to whom there is an obligation to assign the application.

(d) Individuals other than the attorney, agent or inventor may comply with this section by disclosing information to the attorney, agent, or inventor.